7.03 Problem Set 2

Due before 5 PM on Friday, September 29

Hand in answers during recitation section or in the box outside of 68-120

1. Hemophilia A is a X-linked recessive disorder characterized by dysfunctional blood clotting, due to a mutation in the gene for the clotting component, Factor VIII.

Jennifer's brother has hemophilia A, but neither Jennifer nor anyone else in her family show symptoms of the disorder.

a) If Jennifer has a son, what is the probability that he will have hemophilia?

b) Would this probability be different if Jennifer's husband had hemophilia? Explain.

Imagine that there is a DNA-based marker on the X chromosome that is 5 cM away from the gene for Factor VIII. This marker has two alleles, designated x1 and x2, that can be distinguished by a simple analysis of the DNA in a blood sample. The genotype of Jennifer for this marker is x1/x2, the genotype of her mother is x1/x2, the genotype of her father is x2, and the genotype of her brother is unknown.

c) Draw pictures to illustrate all possible arrangements of the given alleles for both of Jennifer's X chromosomes. Be sure to account for both of the DNA marker alleles and both alleles of the gene associated with hemophilia A.

d) What is the probability of each of the above arrangements occurring?

e) Given that Jennifer is a carrier, which of the above arrangements must be correct?

f) Given that Jennifer is a carrier, what is the probability that she will have a son that carries the x2 allele and has hemophilia?

2. The traits controlled by three autosomal *Drosophila* genes are easily distinguishable, since one locus determines body color, one eye color, and the other wing size. Mutants homozygous for recessive alleles of these genes exhibit black body (b/b), purple eyes (pr/pr), and vestigial wings (vg/vg). [Wild-type flies have brown bodies, red eyes, and large wings.]

The gene order is Vg—Pr—B and the distance between Vg and Pr is 13 cM and the distance between Pr and B is 7 cM. You cross a fly from a true-breeding line with brown body, red eyes, and large wings to a fly from a true-breeding line with black body, purple eyes, and vestigial wings. The F1 progeny (which have brown bodies, red eyes, and large wings) are then crossed to flies with black body, purple eyes, and vestigial wings. List all of the phenotypic classes that you would expect from this cross and calculate the number of each class expected out of a total of 1000 progeny.

3. Consider two unlinked yeast genes, His3 and His4. Each of these genes encodes an enzyme in the histidine biosynthesis pathway. Therefore, the His3$^-$ and His4$^-$ mutants require histidine for growth (i.e. the mutants are phenotypically His$^-$).

a) You mate a MAT**a** His3$^-$ strain to a MATα His4$^-$ strain to produce heterozygous diploids. If the resulting diploids are His$^+$ what does this tell you about the His3$^-$ and His4$^-$ mutations?

b) Next you sporulate the diploids to produce 60 tetrads. Describe the types of tetrads you should get (in terms of the ratio His$^+$: His$^-$) and the expected number among the 60 tetrads.

c) Would you expect the result from part (b) to be different if both the His3$^-$ and His4$^-$ mutants were dominant? Explain.

d) Now you cross a wild type MAT**a** strain to a MATα His3$^-$ His4$^-$ double mutant. Out of 60 tetrads from this cross, how many of each tetrad type would you expect to get?

e) The His4 gene is relatively large. Say that you have a His4-1$^-$ mutation that is at one end of the gene and a His4-2$^-$ mutation at the other end of the gene. If the His4-1$^-$ and His4-2$^-$ mutations are exactly 1 cM apart, how many of each tetrad type would you expect from a cross of a MAT**a** His4-1$^-$ strain with a MATα His4-2$^-$ strain (you analyze a total of 50 tetrads)?

f) How many of each tetrad type would you expect from a cross of a MAT**a** His4-1$^-$ strain with a MATα His4-1$^-$ His4-2$^-$ double mutant (you analyze a total of 50 tetrads)?